CERES EBAF-TOA

Norman G. Loeb, NASA LaRC
L. Liang, C. Nguyen, Z. Eitzen, C. Mitrescu, F. Rose SSAI
S. Kato, D. Doelling, NASA LaRC

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Energy Balanced and Filled (EBAF): All-Sky

- For July 2005-June 2010, 0-1800 m upper ocean ocean heating rate from Argo is 0.47±0.43 Wm^{-2} (90% conf).
- Assume: 0.07±0.05 Wm^{-2} contribution at depths below 2000 m, and 0.04±0.02 Wm^{-2} from ice warming and melt, and atmospheric and lithospheric warming.

=> Net planetary imbalance for July 2005-June 2010: 0.58±0.43 Wm^{-2}

- At shorter timescales (e.g., annual), uncertainty in Argo-based ocean heating rate increases dramatically due mainly to sampling uncertainties.
- CERES absolute calibration uncertainty in total outgoing radiation (SW+LW) is 1.5% (95% conf), too large to provide an independent absolute measure of net TOA imbalance.
- However, CERES measurements are stable to a few tenths of a Wm^{-2} per decade and provide excellent regional coverage of Earth's reflected and emitted radiation.

CERES Energy Balanced and Filled (EBAF) Ed2.6r:

- Apply an objective constrainment algorithm to adjust CERES SW and LW TOA fluxes within their range of uncertainty to provide a net TOA imbalance consistent with Argo-based value.

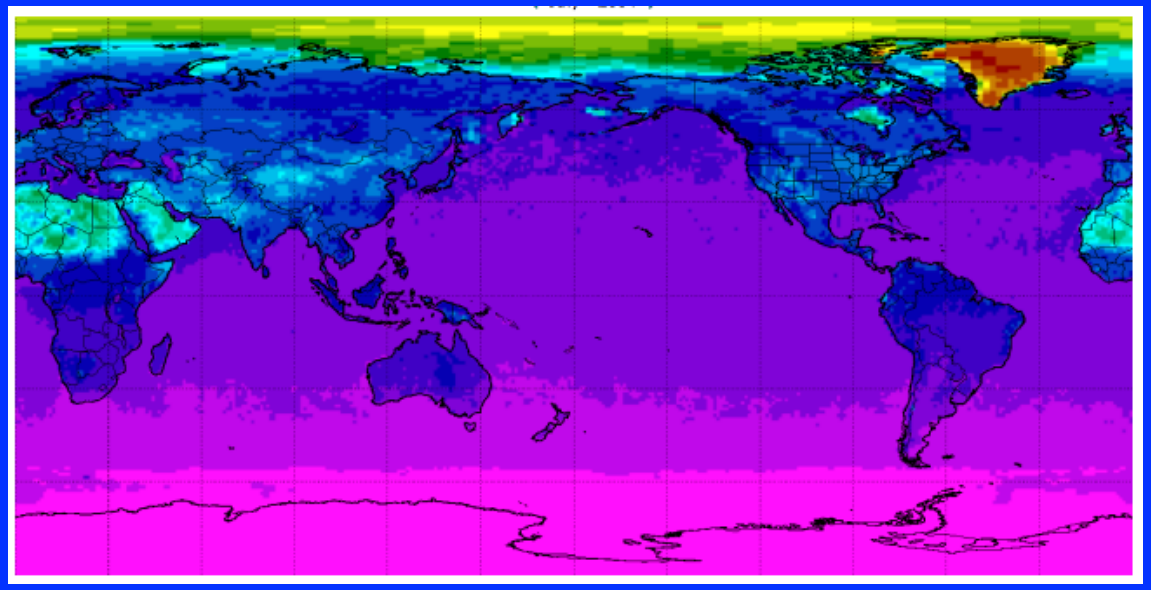
=> CERES EBAF provides monthly regional global net radiation constrained by an Argo-based net TOA imbalance value (from PMEL/JPL/JIMAR analysis).

Energy Balanced and Filled (EBAF): Clear-Sky

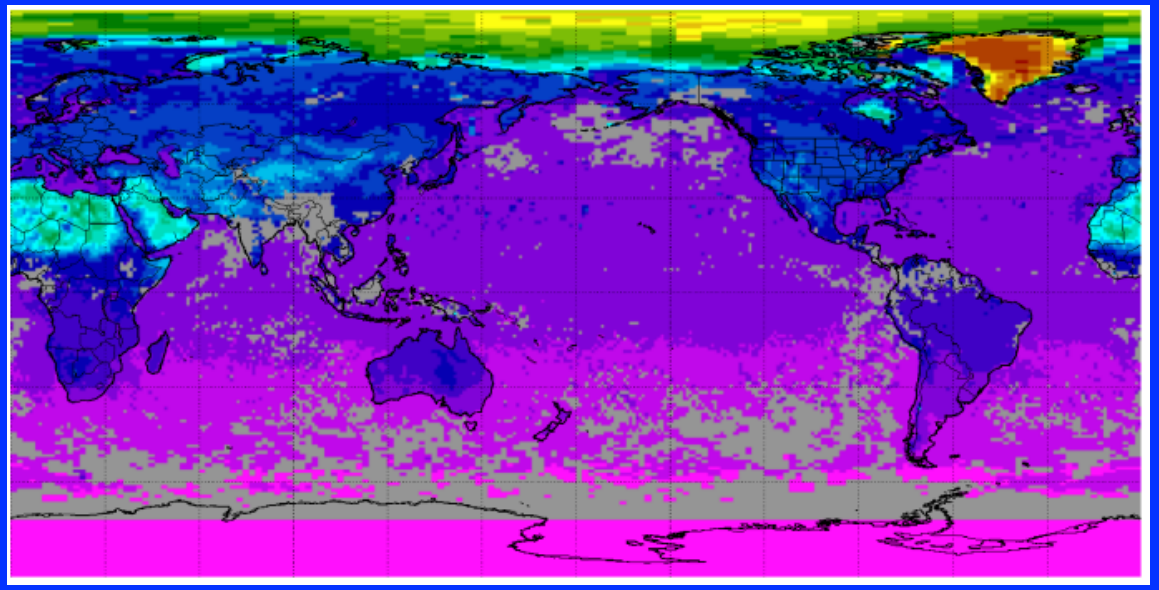
- Clear-sky fluxes in standard CERES data products (SSF1deg, SYN1deg) are determined from CERES footprint that are completely cloud-free.
- In regions of persistent cloud cover, there are very few (if any) cloud-free regions at the CERES footprint scale, resulting in missing regions.
- Clear fluxes only provided for large clear regions => “Dry” bias.
- EBAF supplements the clear-sky sampling by also inferring TOA fluxes from the cloud-free portion of partly cloudy CERES footprints:
  - Use narrow-to-broadband regressions derived from CERES and MODIS to convert MODIS radiances averaged over the clear area of a footprint to broadband.
  - Infer TOA flux from CERES ADMs.
  - Weight footprints by clear area coverage (number of imager pixels).
  - Apply bias correction to remove the regional error in the narrow-to-broadband regression.
- EBAF Ed2.6r: N2BB for ocean and land only
- EBAF Ed2.7: N2BB for ocean, land, snow, sea-ice.

Clear-Sky SW TOA Flux (July 2004)

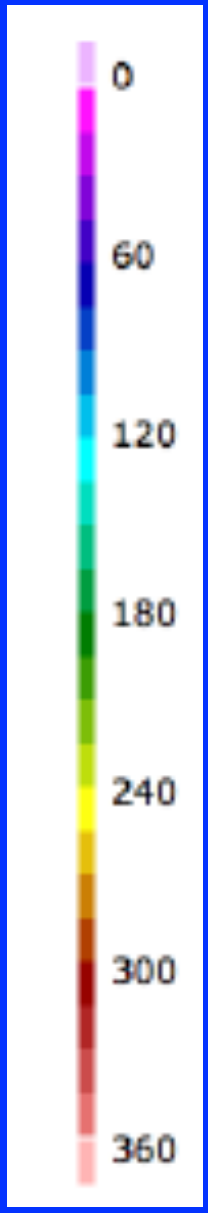
CERES EBAF Ed2.7



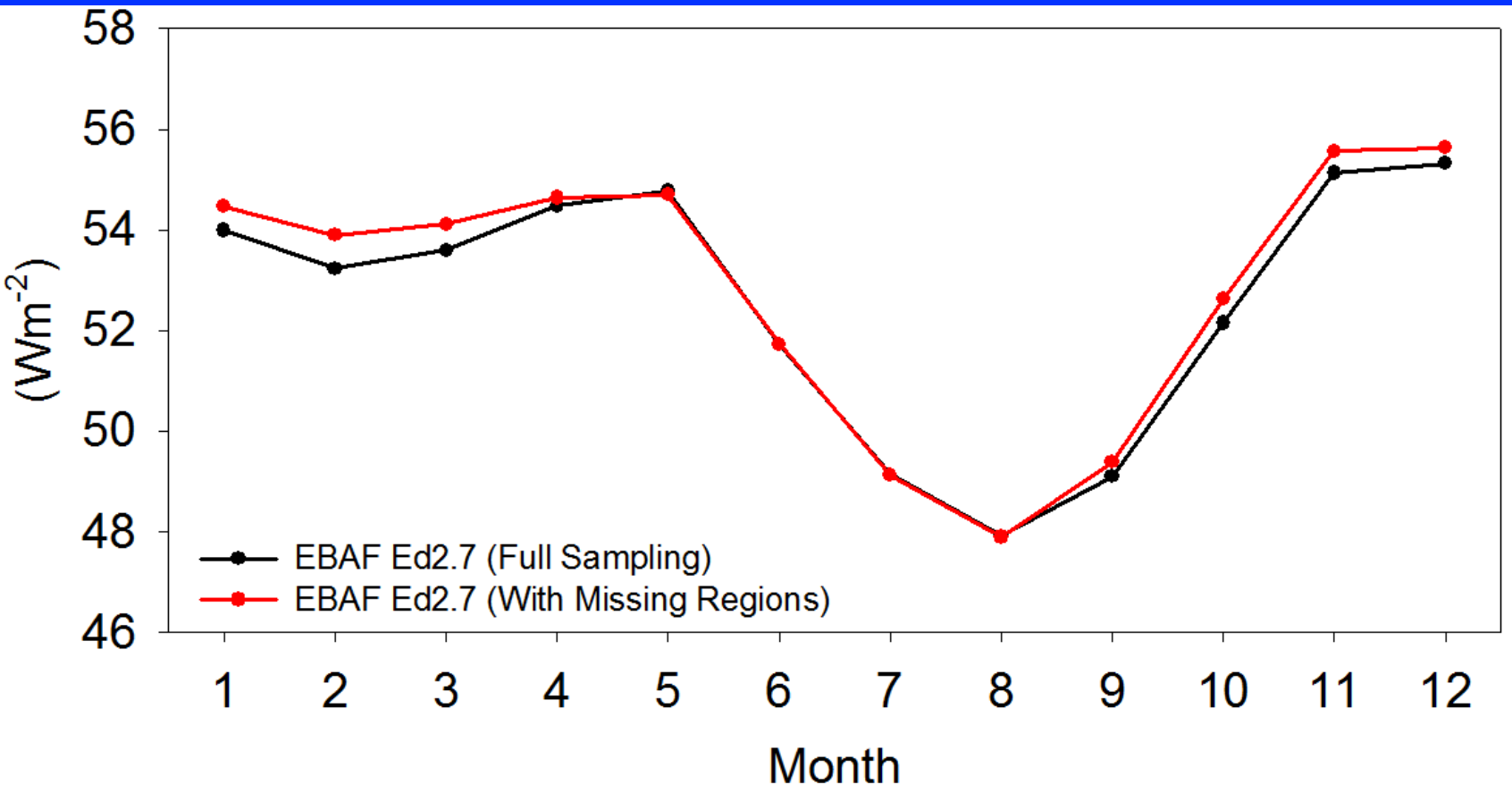
CERES SSF1deg-lite Ed2.6



Wm^{-2}



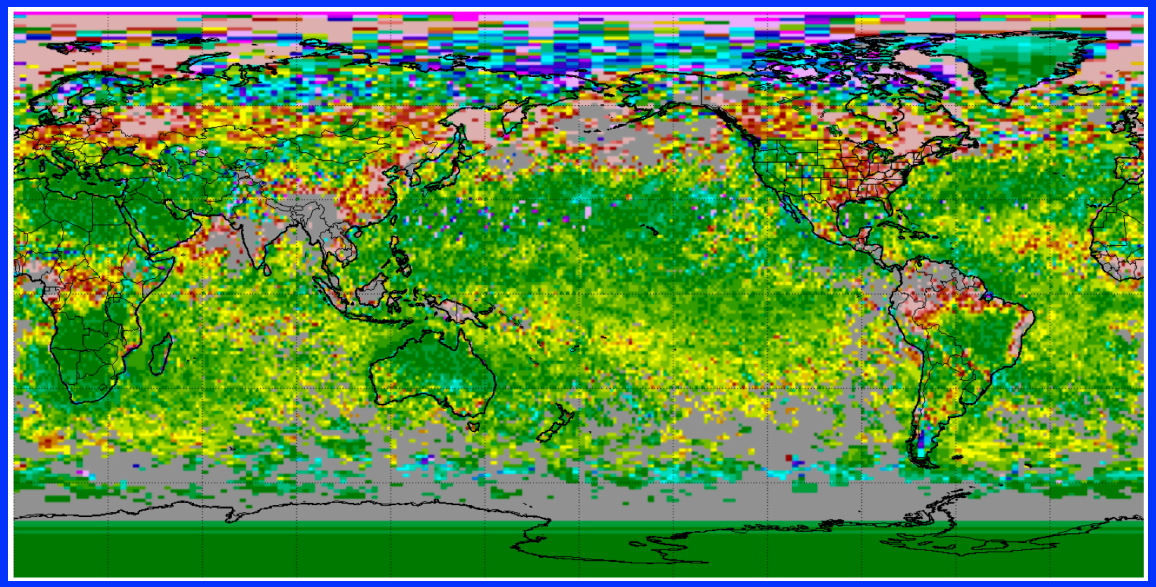
Clear-Sky SW TOA Flux Annual Cycle Sensitivity to Missing Regions



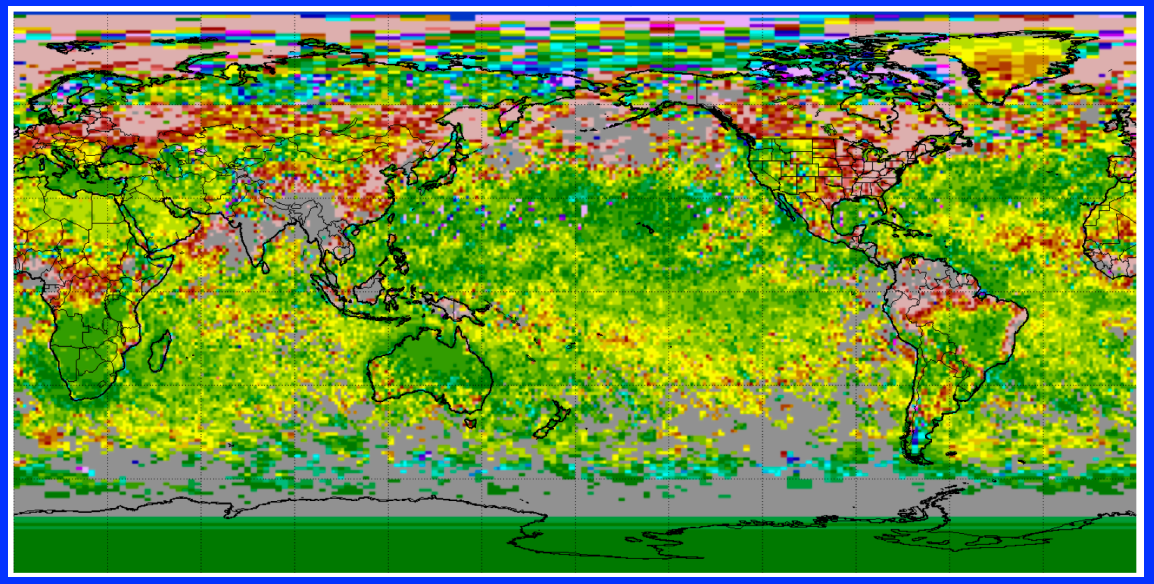
- Compare full EBAF sampling with that obtained when regions missing in SSF1deg are excluded from EBAF.
- Reduced sampling increases amplitude of annual cycle.
- Larger difference in DJF clear-sky SW TOA flux is due to influence of missing regions in southern oceans.

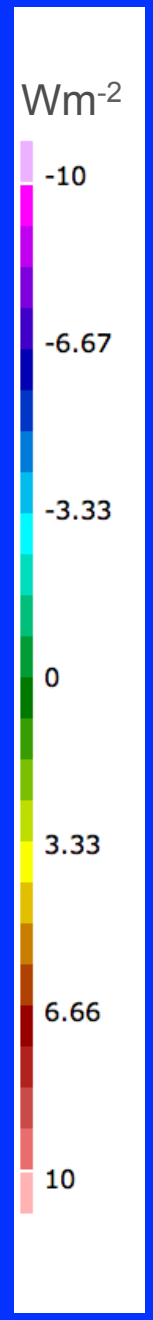
Clear-Sky SW TOA Flux: High vs Coarse Spatial Resolution Sampling (July 2004)

Spatial Sampling
Hires_Clr – SSF1deg
$\Delta F = 1.9\ Wm^{-2}$



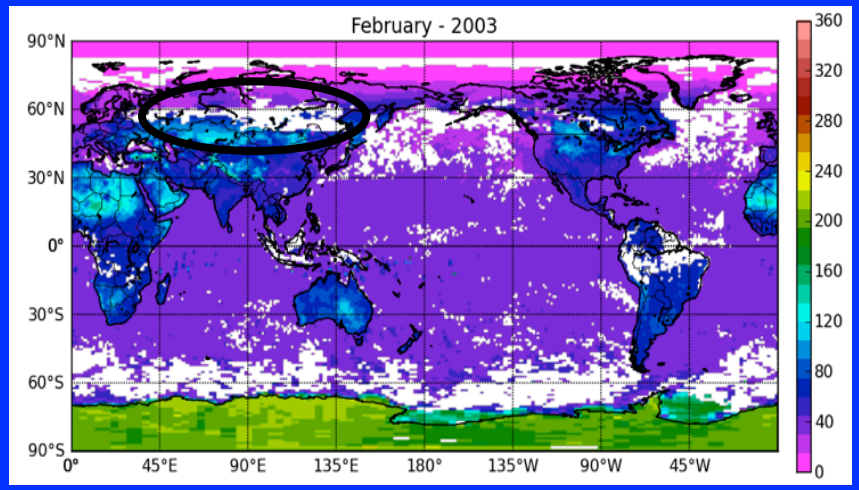
Spatial Sampling & Calibration
EBAF – SSF1deg
$\Delta F = 2.8\ Wm^{-2}$



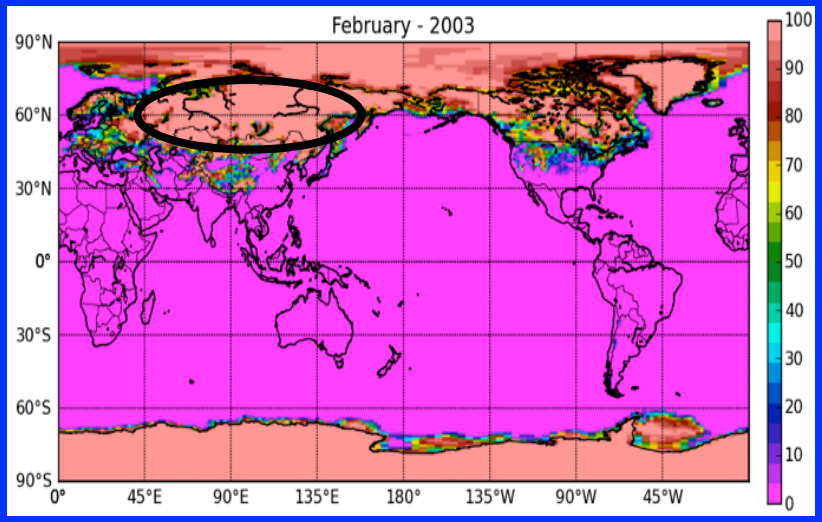


Monthly Mean Clear-Sky SW TOA Flux (Feb 2003)

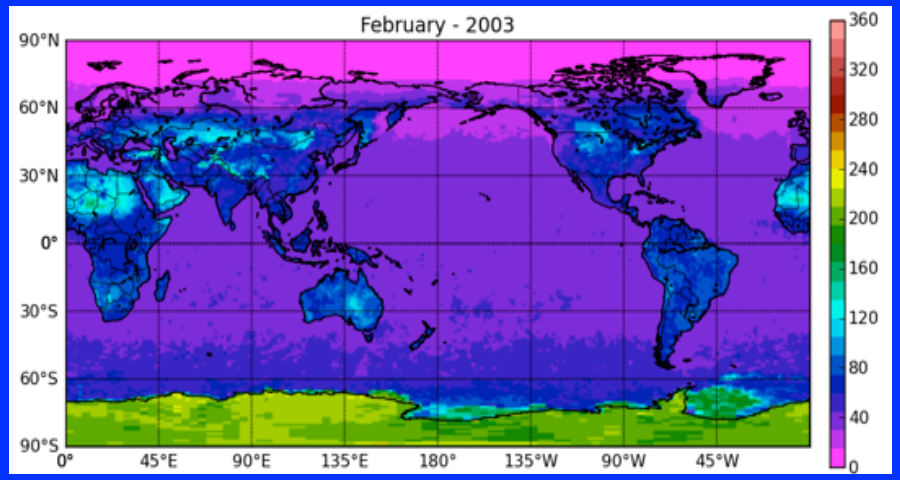
CERES SSF1deg



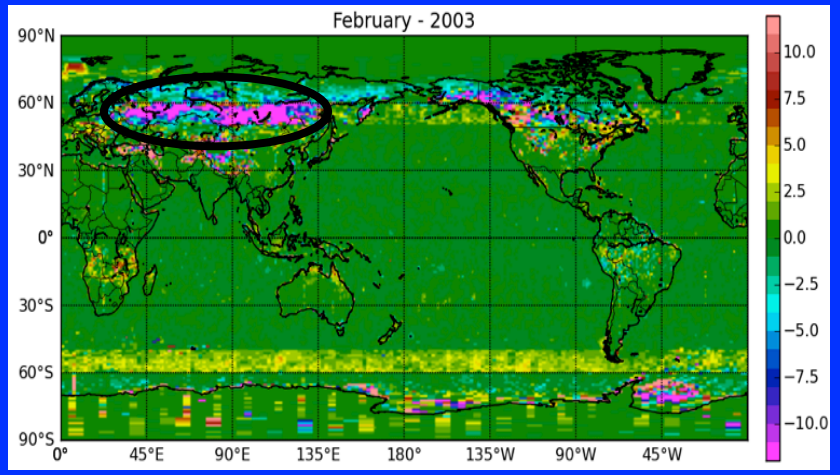
Snow/Ice Percent Coverage



CERES EBAF Ed2.7

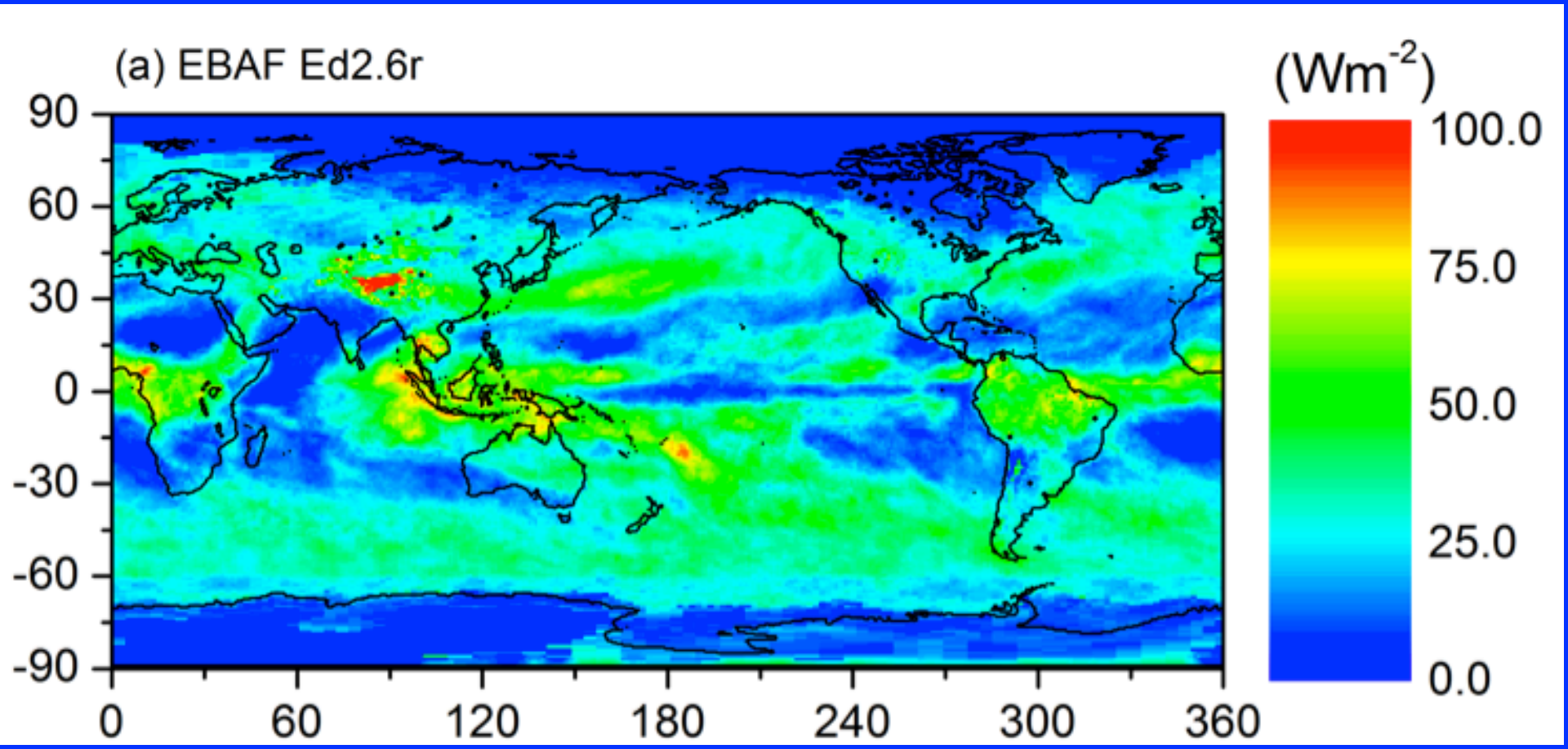


EBAF Ed2.7 minus Ed2.6r



- Large differences in snow regions with missing SW TOA Flux in SSF1deg. These are spatially interpolated in EBAF Ed2.6r but directly observed in EBAF Ed2.7.

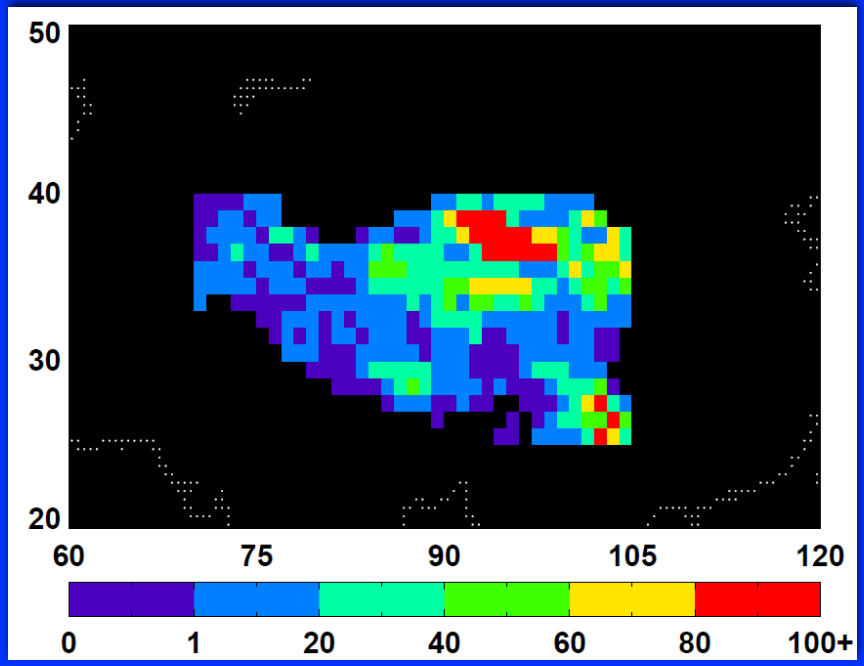
EBAF Ed 2.6r TOA LW CRE for April 2000



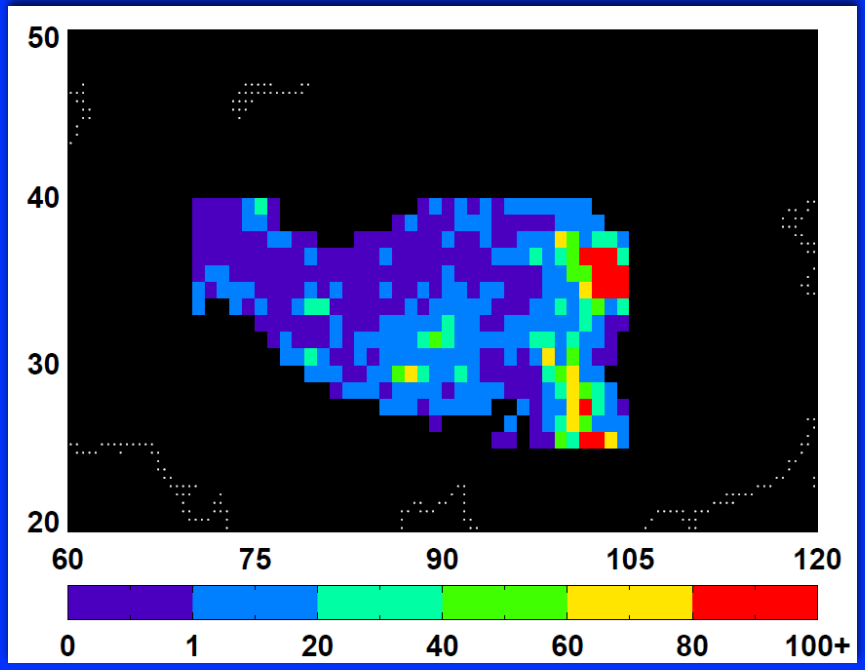
- Anomalous LW CRE over Tibet Plateau

Ed2 200104 number of clear FOVs

Daytime

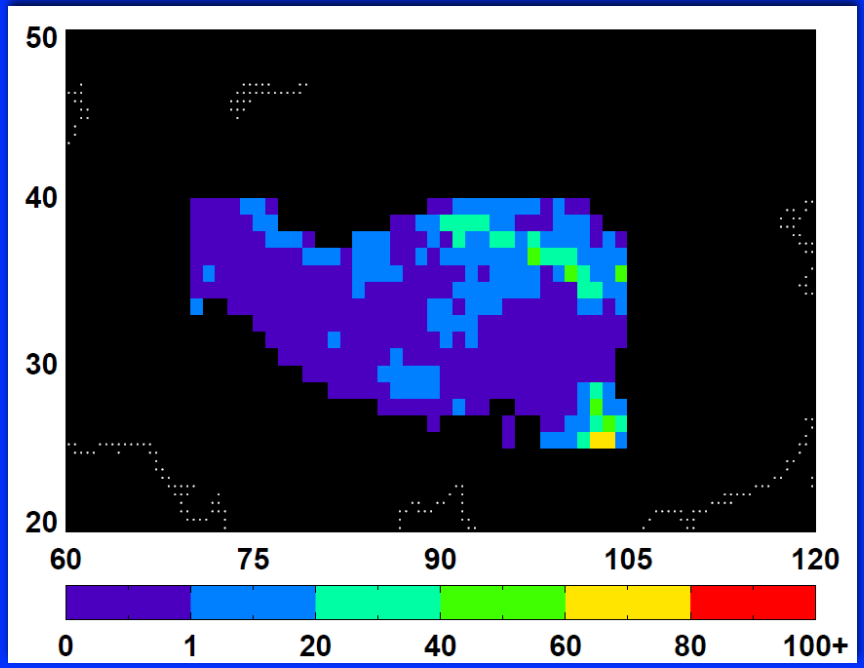


Nighttime

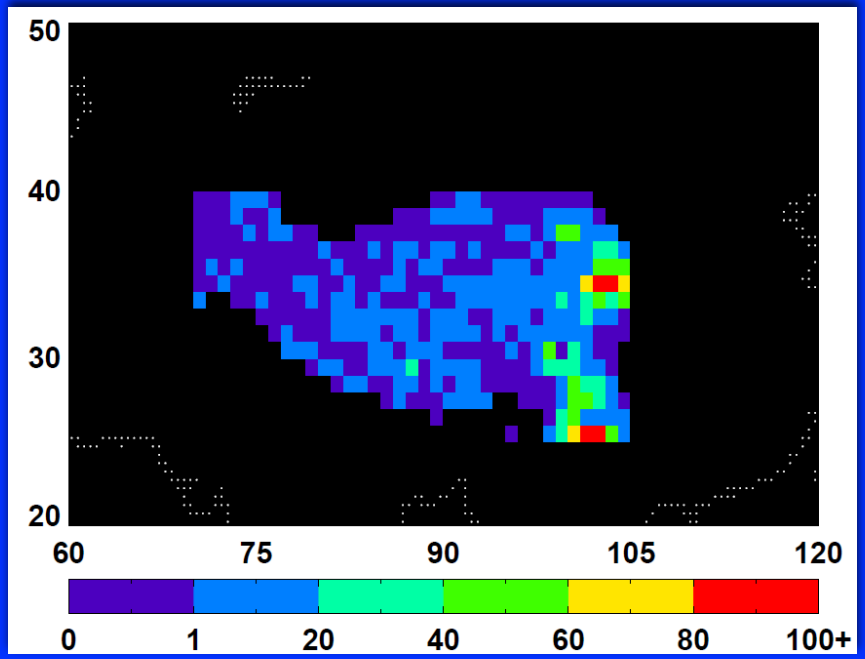


Ed4 200104 number of clear FOVs

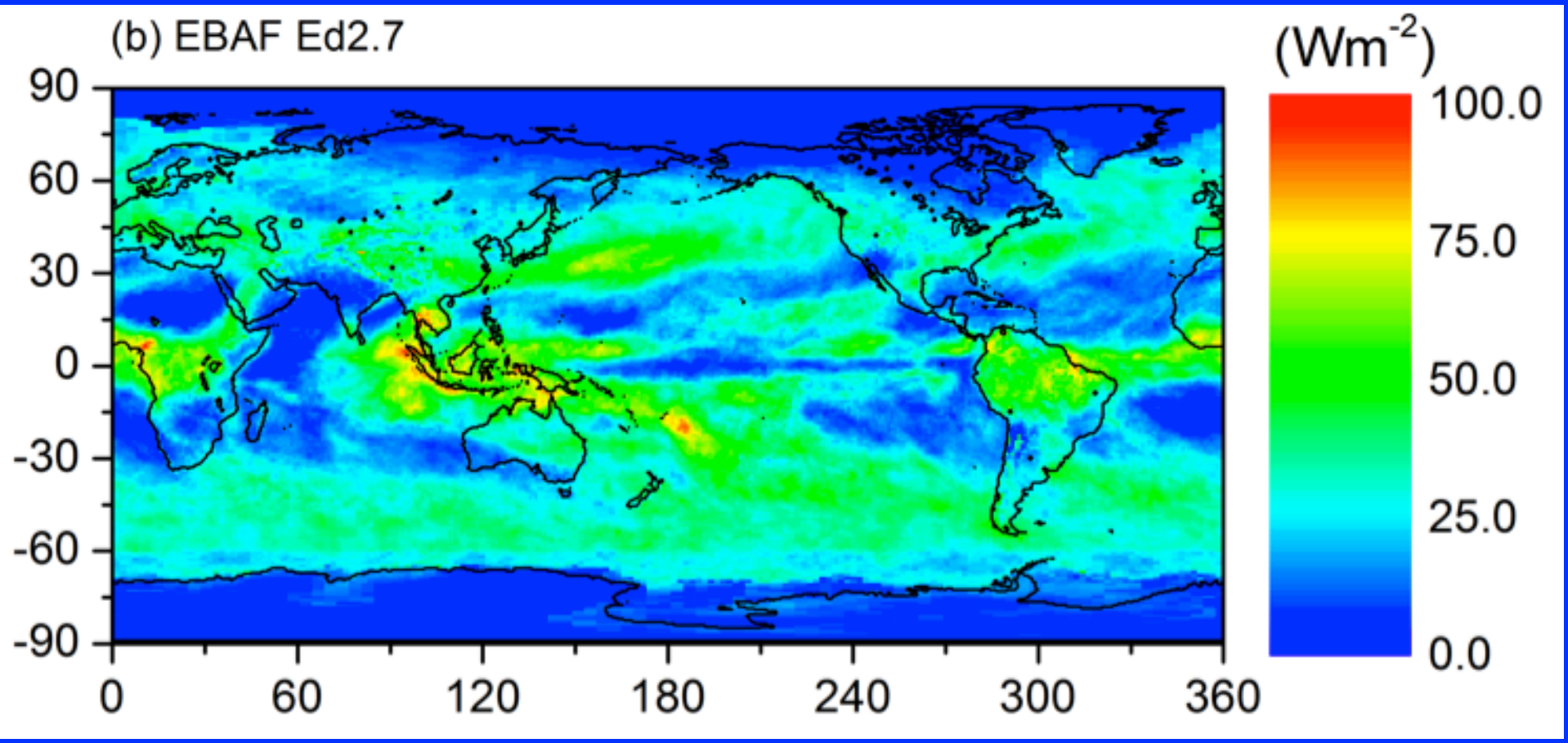
Daytime



Nighttime



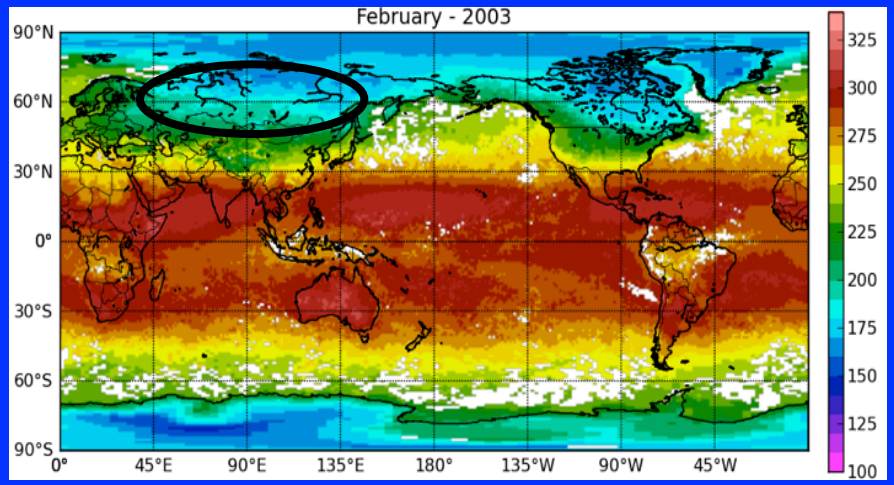
EBAF Ed 2.7 TOA LW CRE for April 2000



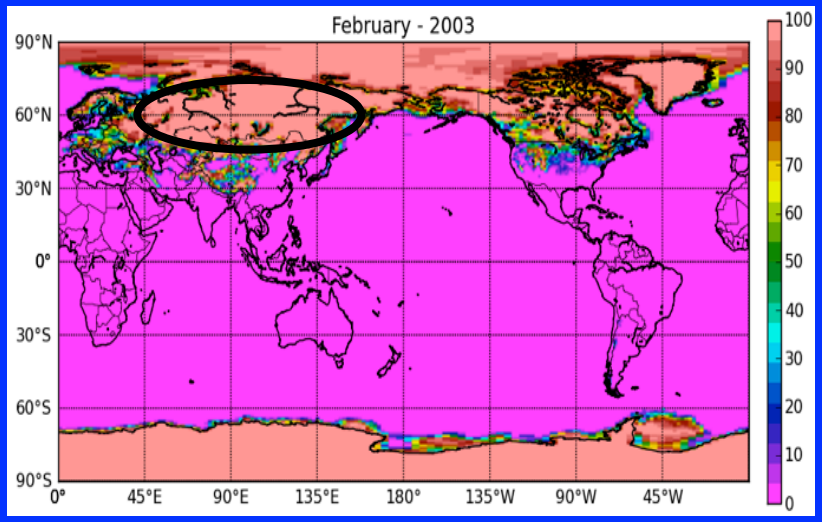
- EBAF Ed2.7 now infers clear-sky from partly cloud over snow & sea-ice
- Anomalous LW CRE over Tibet Plateau removed

Monthly Mean Clear-Sky LW TOA Flux (Feb 2003)

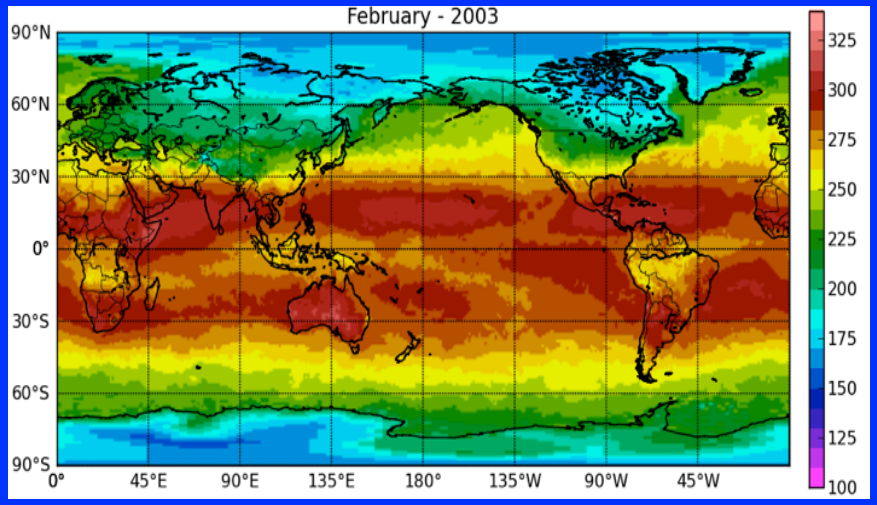
CERES SSF1deg



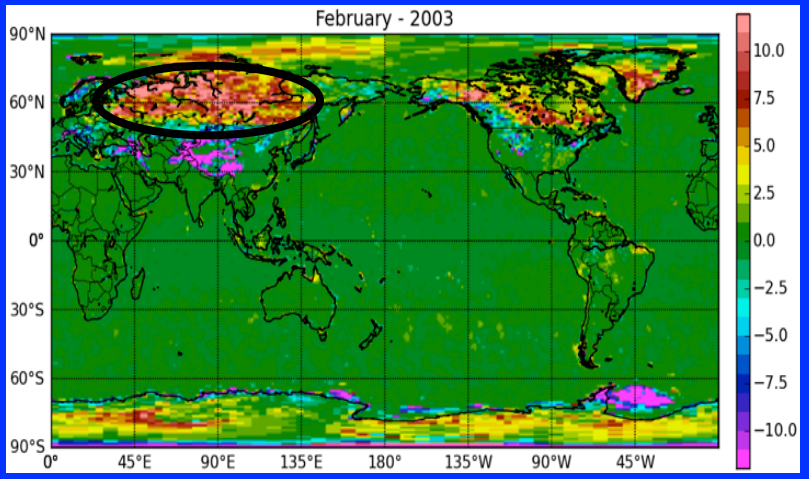
Snow/Ice Percent Coverage



CERES EBAF Ed2.7



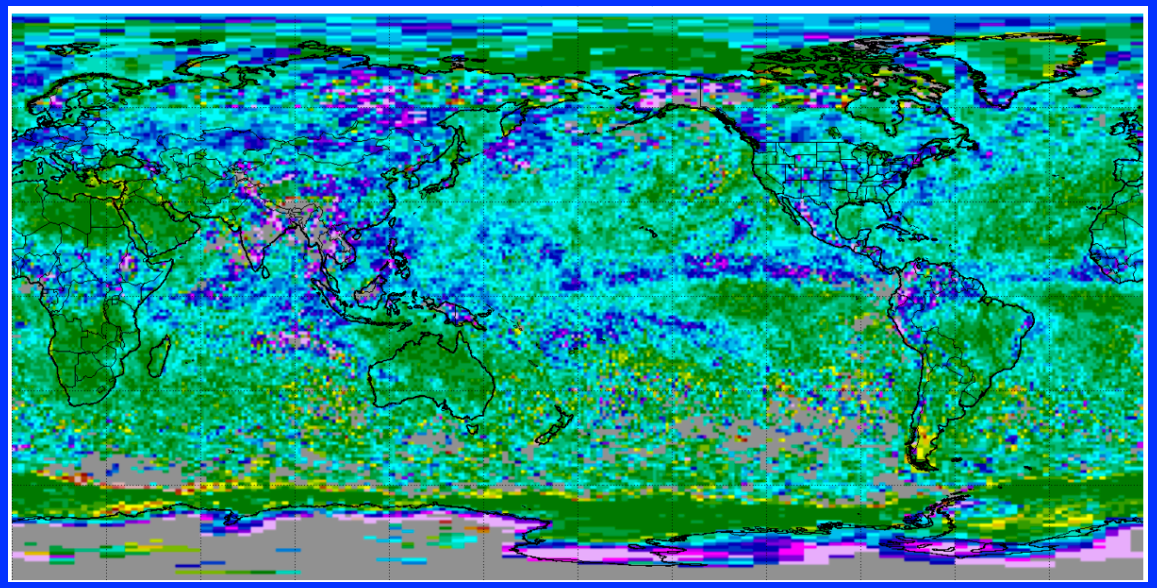
EBAF Ed2.7 minus Ed2.6r



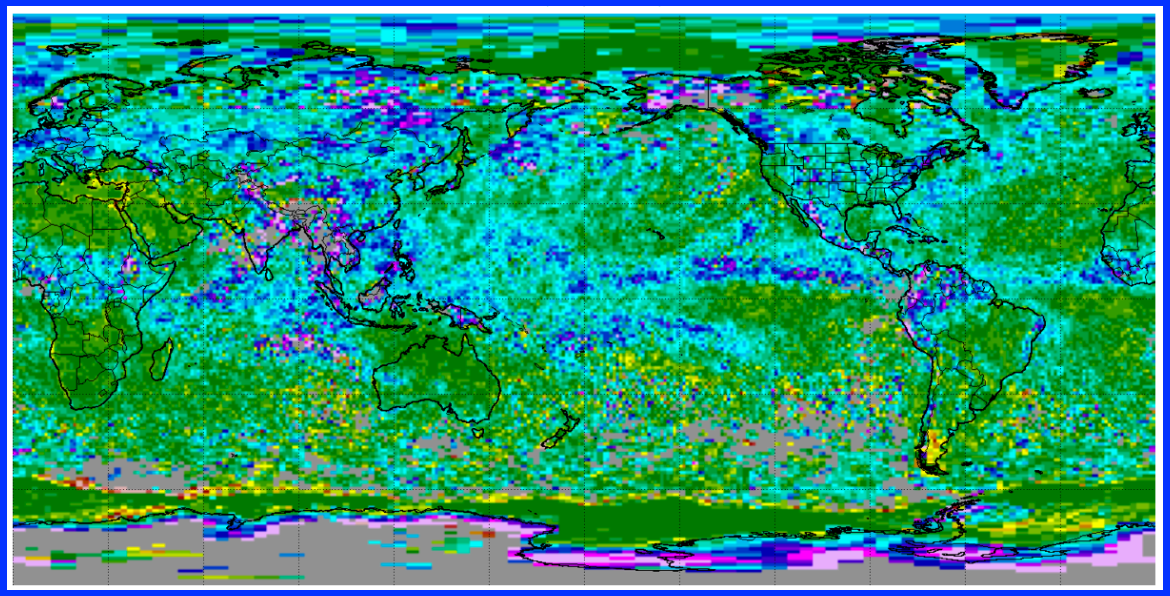
- Large differences in regions of missing LW TOA Flux in SSF1deg. These are spatially interpolated in EBAF Ed2.6r but directly observed in EBAF Ed2.7.

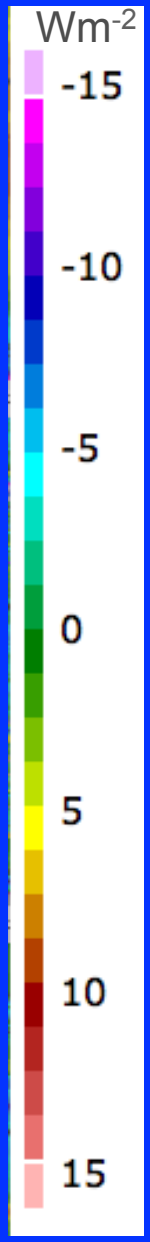
Clear-Sky LW TOA Flux: High vs Coarse Spatial Resolution Sampling (July 2004)

Spatial Sampling
Hires_Clr – SSF1deg
ΔF = -3.1 Wm^{-2}

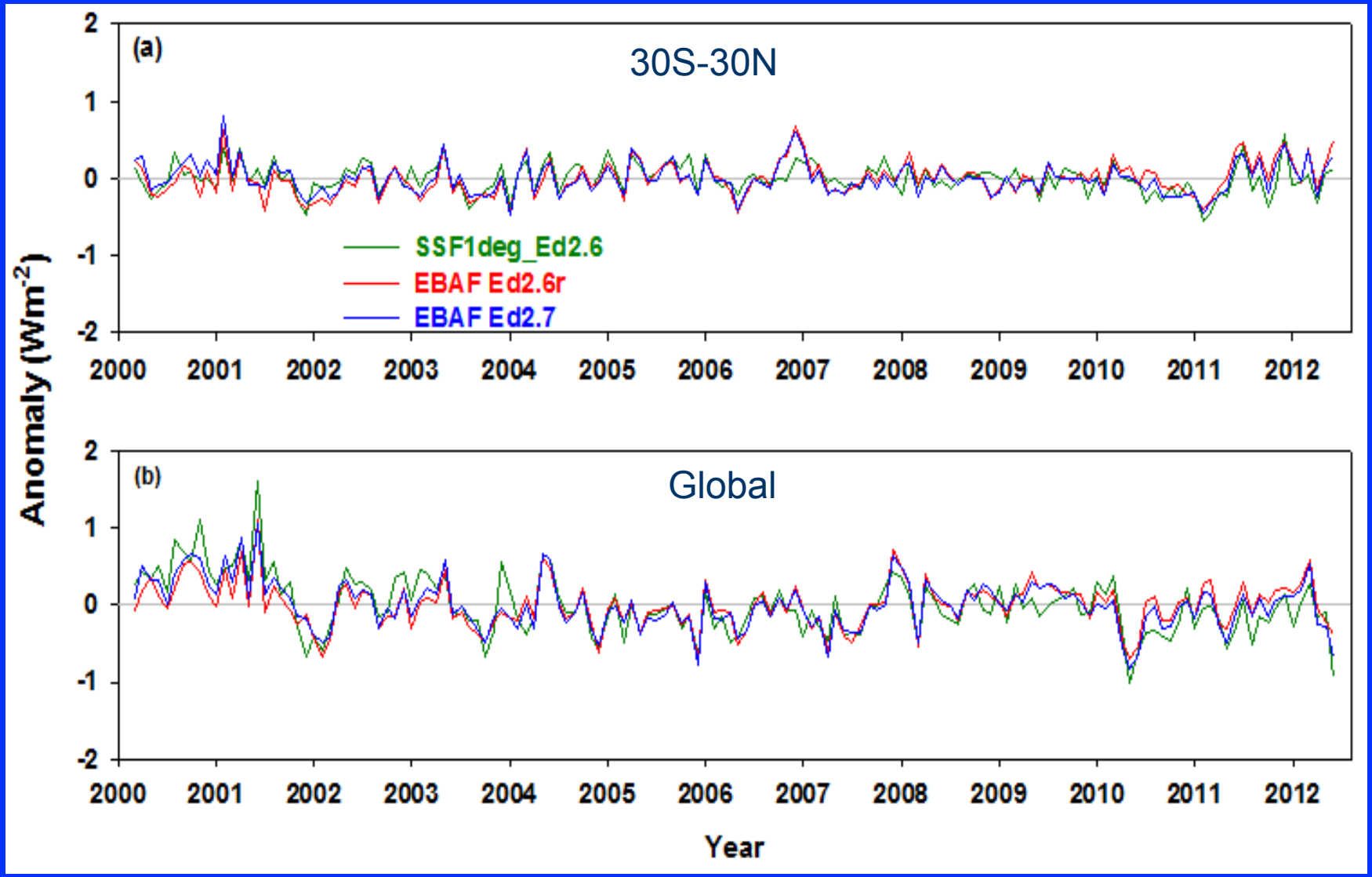


Spatial Sampling & Calibration
EBAF – SSF1deg
ΔF = -2.1 Wm^{-2}

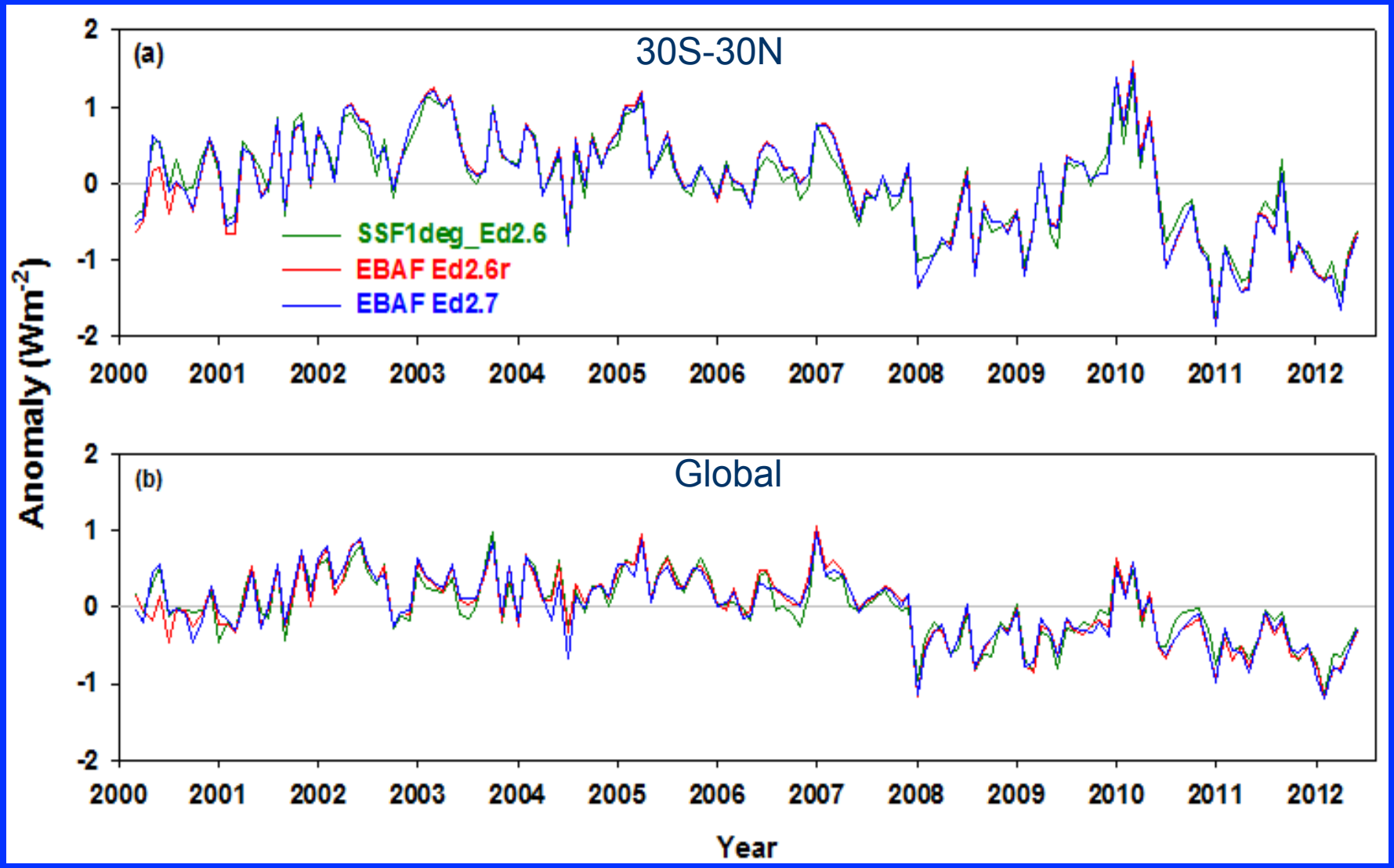




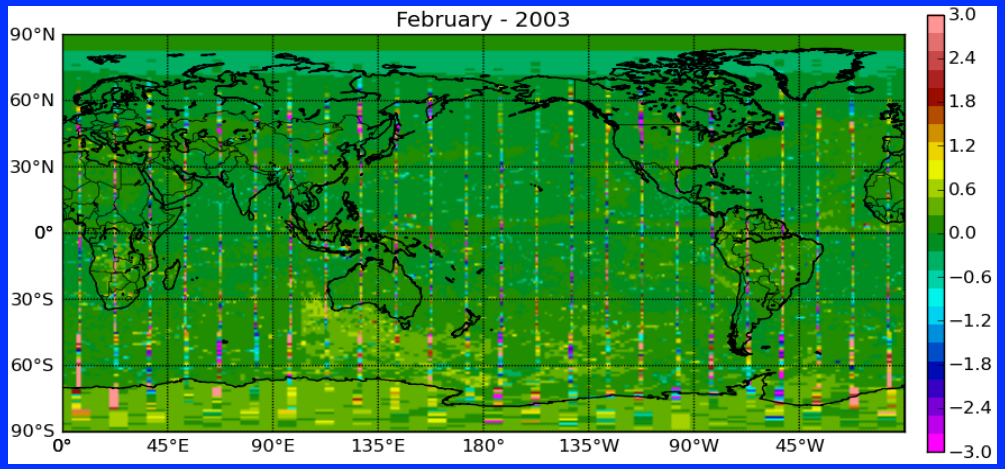
Monthly Clear-Sky SW TOA Flux Anomalies

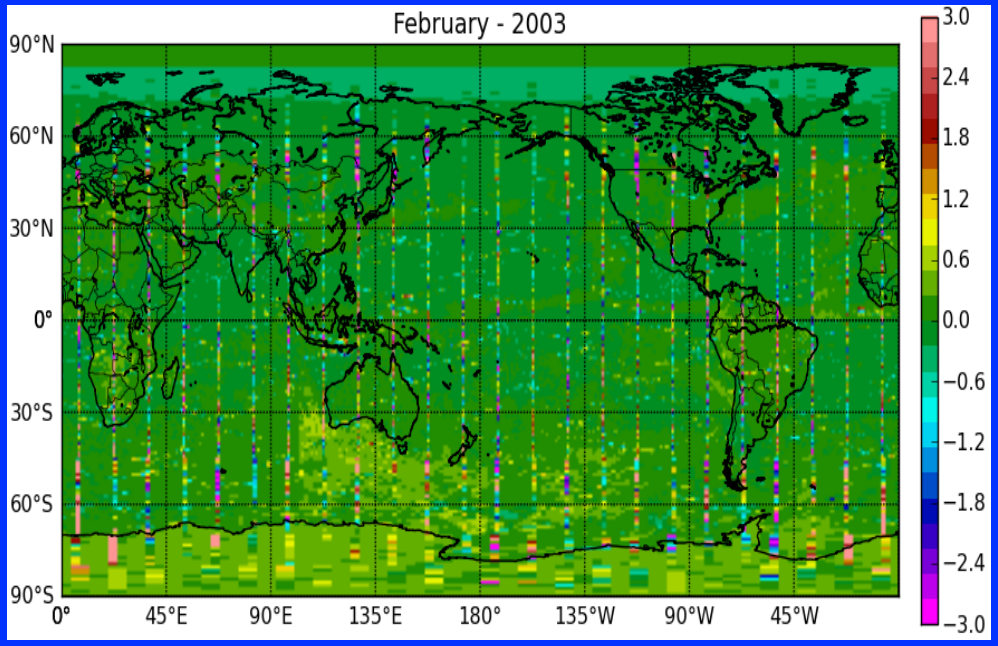


Monthly Clear-Sky LW TOA Flux Anomalies



All-Sky SW and LW TOA Flux Difference: EBAF Ed2.7 minus Ed2.6r





Summary

- Large differences in clear-sky flux between standard CERES (SSF1deg, SYN1deg) and EBAF due to differences in clear-sky spatial sampling.

- There is a trade-off between minimizing cloud contamination in clear-sky fluxes and providing spatially complete clear-sky maps. There is also the issue of a “dry bias” in LW.

- EBAF Ed2.7 provides high-resolution fluxes over snow and sea-ice. Improved sampling removes erroneous LW CRE over Tibet and erroneous SW flux “fill” values over snow in cloudy regions.

- Differences between SSF1deg and EBAF clear-sky TOA flux monthly anomalies are larger for SW than LW.

- Minor differences in all-sky SW and LW TOA flux for EBAF Ed2.6r and EBAF Ed2.7.